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ABSTRACT

The focus of this project was to individualize mathematics instruction for fifth- and sixth-grade students. Tapes and student study sheets were prepared for different ability levels. These materials allowed teachers to place students in a self-instruction package commensurate with the students' ability and allowed students to proceed at their own rate. The audio-tutorial component insured that students who had reading problems could make use of the individualized instruction The program freed the teacher to work with students individually and prepare for whole-class activities. The program's success was assessed by measuring achievement on standardized pre- and posttests, and comparing the results with results from regular classrooms. The differences on achievement gain between the two groups were significant at the .01 level for tests on arithmetic computation, arithmetic concepts, arithmetic applications and symbols and vocabulary; all differences favored the individualized instruction group. A cost-accounting comparison indicated little monetary difference. Complete statistical data and budget costs are included. This work was prepared under an ESEA Title III contract. (JP)

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ED 086544

SUCCESS IN MATHEMATICS THROUGH AURAL READING TECHNIQUES (SMART)

Mr. Frank Sganga, Project Director
Mr. Jack Duncan, Project Manager

Mr. Raymond O. Dunne
Superintendent
Volusia County Schools

February, 1973

This project is one of the Florida Elementary and Secondary Education Act, Title III projects validated as innovative, effective, cost-effective, and exportable during 1973. The information which follows has been excised from the project's validation report and is composed of

(1) an abstract featuring the focus of the project, the objectives, the activities, the evaluation, and the findings;

(2) a summary of the project for exportability featuring an introduction, the context of the program, a program description, a cost-effectiveness analysis, and a description of the evaluation procedures; and

(3) the conclusions and recommendations of the four member, out-of-state validation team on innovativeness, effectiveness/success, cost effectiveness, and exportability.

For additional information, please contact the project director or manager indicated on the following page.

SE 017 205

SUCCESS IN MATHEMATICS THROUGH AURAL READING TECHNIQUES (SMART)

Mathematics: Grades Five and Six

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ABSTRACT

FOCUS: The focus of this project was to individualize mathematics' instruction using locally prepared tapes and student study sheets. Each student had a tape player equipped with earphones which allowed him to proceed at a rate commensurate with his ability. By recording the math lessons, an attempt was made to relieve the teacher of the necessity of merely dispensing information so that he would be free to work with students individually. Also, the tapes permitted the student to make progress in math even if he was a poor reader.

OBJECTIVES: The major objectives of the project were:

1. The fifth and sixth grade students will be able to use computational skills more nearly commensurate with their aptitude as evidenced by pre- and post-test gains of the Stanford Math Achievement Tests when compared with a control group.

2. The fifth and sixth grade students will be able to use computational skills more nearly commensurate with their aptitude as evidenced by pre- and post-test gains of the Math Symbols and Vocabulary Test when compared with a control group.

3. The sixth grade students will be able to use computational skills more nearly commensurate with their aptitude as evidenced by pre- and post-gains on the Volusia County Math Survey when compared with a control group; and the general ability of the experimental and control groups will be measured by the Toga Test.

ACTIVITIES: The first phase of the program was student diagnosis and orientation; the student's computational skills were diagnosed using general achievement and "facts" test. After diagnosis, the student was placed in a unit (student study booklet and tape) which was best suited to meet his mathematical needs. He would listen and study for a couple of "steps," then turn off the machine and do the next "step"

which was a practice exercise. The answers were checked using "Key to Practice Exercises" found in the appendix of the student study booklet.

If there were errors, other than careless mistakes, he could replay the tape or consult his instructor. These procedures continued until the student completed his booklet and passed a test covering the booklet.

EVALUATION: The students in the experimental and control groups were pre- and post-tested using Stanford Math Achievement, Math Symbols and Vocabulary and Volusia County Math Survey Tests. The groups were heterogeneous, matched for grade, and of comparable mathematical ability.

FINDINGS: An analysis of covariance was performed by Dr. Louis Bashaw at the University of Georgia. On all tests, the gains were in favor of the experimental group at the .01 level.

COMMENTS:

1. The materials were found to be more successful in heterogeneous situations.

2. The students do not work on the tapes all the time, but they are their main vehicle for math instruction. The teacher will supplement the program with "whole class activities," individual and small group activities, commercially produced workbooks, textbooks, and manipulative aids.

3. There is no need for a one-to-one correspondence between tape players and students; the ratio is about 2 to 3, players to students. The materials can be used in listening centers.

SUMMARY OF PROJECT FOR EXPORTABILITY

A. INTRODUCTION

Basically, the design is to individualize mathematics instruction using specially-prepared tapes and student study sheets. Each student has a tape player equipped with earphones which allows him to proceed at a rate commensurate with his ability. By recording the mathematics lessons, we hope to relieve the teacher of the necessity of merely dispensing information so that he will be free to work with students individually. We want to help each student with HIS particular problem, to remove the pressure to "keep up" that is inherent in lecture-type, whole-class-orientated situations, and to allow the more mathematically capable student to forge ahead without restraint.

Finally, our ultimate goal is to help every student achieve success in mathematics by providing him with as much personal attention as possible.

B. CONTEXT OF PROGRAM (Community and Environment)

The Volusia County School System serves about 35,000 students through 52 schools. About 25% of the student population lives in rural areas. Our school system and the community it serves contains no unique factors that would hinder the exportation of Project SMART.

C. PROGRAM DESCRIPTION

1. SCOPE (target population and objectives)

Initially, the project was designed to serve low achievers in mathematics at the secondary level. However, during our first year of operation, we became aware of the need to apply our techniques of individualizing instruction to the elementary level. It was at this level that we started serving the total population.

PRIMARY OBJECTIVE: The student will be able to use computational skills more nearly commensurate with his aptitude as measured by the STANFORD ACHIEVEMENT TEST as indicated by significantly higher scores on a post test.

SECONDARY OBJECTIVES:

a) Improve reading skills
b) Improve students' self-concept by having them work at their own level using success-oriented materials. They will thereby perceive themselves as better math students.
c) Allow students to work independently at their own levels.
d) Teachers will be free to work 90% of the instructional time individually with students.
e) Improve teachers attitude toward meeting individual needs of students.

2. ACTIVITIES

Each classroom is equipped with a tape player and a headset for each student. Prepared tapes will be available for each student's use. These will guide him through mathematical concepts and processes in small steps. As he listens to the tapes he will be responding on specially-prepared work-sheets. While the worksheets will be in outline form, the tapes will contain detailed explanations aimed at providing a depth of understanding of the topic.

At the start of the year, the level of each student's ability in math is determined, and he begins work in the appropriate booklet. Each booklet contains detailed explanations, practice exercises, review exercises, and self tests. Successful completion of a self test allows a student to take an achievement test which is administered by the teacher. Three achievement tests (A,B, and C) are available for each unit of work.

After completing the practice exercises in his booklet the student can compare his results with answer sheets readily available to him. Incorrect responses will be checked and and corrected. If the student has difficulty in locating his errors, he may replay the tape or consult the instructor. The importance of these two features cannot be overemphasized. The tireless tape can be immediately rewound and replayed as often as necessary.

What is even more important, however, is the fact that the student may go to the teacher's desk to get his question answered WITHOUT FEAR OF EMBARRASSMENT. This personal aspect of the program is of prime importance in mathematics where to fall behind is tantamount to failure due to the highly-structured nature of the subject. With this approach the teacher will also be free to circulate among students to help them as needed.

Care will be taken to ensure that activities are varied and reasonably short. While the primary emphasis will be on the individualization of instruction, there will also be regularly scheduled "WHOLE CLASS ACTIVITIES" to foster the interchange of ideas through group discussions. Such activities will involve areas of mathematics related to but not dependent upon what has already been learned. (For example, a study of the slide rule, how to count in different number systems, the experimental determination of "pi", and so on.)

3. PRESERVICE AND INSERVICE TRAINING

At the start of the school year, a two-day workshop is held, with one day allocated for orientation of new project teachers. During the orientation, teachers are familiarized with the hardware, software, terminology and the contents of the teacher's manual.

4. FACILITIES

No special facilities are needed.

5. MATERIALS AND EQUIPMENT

CLASSROOM COST

180 students

33 Players @ $22.00	$726
33 Headsets @ $6.00	198
150 Rechargeable Batteries @ $1.00	150
3 Battery Rechargers @ $6.00	18
100 Tapes @ 70¢	70
200 Student Study Sheets @ 10¢	20
	$1182

Cost per pupil for first year $6.57.

Cost per pupil for three years $2.19.

6. PROJECT BUDGET

See next page.

SUPPORTING BUDGET SUMMARY

PROJECT START

State Acct.	Item	Expense Class and Item	Budgeted Amount
		ADMINISTRATION 100	
2014	1	Secretary/Typist	$ 4,500.00
2014	2	Clerk	4,000.00
2014	3	Part-Time Clerk (3 months)	1,000.00
2034	4	Materials and Office Supplies	600.00
		TOTAL ADMINISTRATION	$10,100.00
		INSTRUCTION 200	
2213	1	Stipends and Professional Salaries	25,300.00
2214	2	Professional Salary: Mathematics Specialist	13,955.00
2241	3	Audio-Visual Supplies	2,100.00
2250	4	Teaching Supplies	7,563.00
2260	5	Travel and Per Diem	8,013.00
2270	6	Contracted Services	2,000.00
3030	7	Conference participants other than Volusia County	864.00
		TOTAL INSTRUCTION	$60,300.00
		OPERATION OF PLANT 600	
2340	1	Telephone Service	200.00
		TOTAL OPERATION OF PLANT	$ 200.00
		MAINTENANCE OF PLANT 700	
2420	1	Repair of Instructional Equipment	500.00
		TOTAL MAINTENANCE OF PLANT	$ 500.00

State Acct.	Item	Expense Class and Item	Budgeted Amount
		FIXED CHARGES 800	
2610	1	Workmen's Compensation Insurance	100.00
2660	1	Retirement - Instructional Personnel	3,600.00
	2	Retirement - Non-Instructional Personnel	1,000.00
		TOTAL FIXED CHARGES	$ 4,700.00
		CAPITAL OUTLAY 1230	
2844	1	150 Cassette tape players @ $22.00	3,300.00
	2	150 Headsets @ $7.00	1,050.00
	3	3 Steel storage cabinets @ $70.00	210.00
	4	8 Listening centers @ $50.00	400.00
	5	1 stencil cabinet @ $5.00	75.00
	6	12 Shelves @ $40.00	480.00
		TOTAL CAPITAL OUTLAY	$ 5,515.00
		TOTAL	$81,315.00

D. COST EFFECTIVE ANALYSIS

Prepared by Dr. Crane Walker

The following information provides a cost/benefits analysis of a Title III program entitled SMART (Success in Mathematics through Aural Reading Techniques) and compares its cost/benefits to conventional math instruction as offered in Volusia County. It is hoped that this cost/benefits analysis will impart valuable management information for the evaluation of this project.

Educational costs are very difficult to retrieve and this county is currently expending large sums of money to improve its ability to retrieve costs related to specific programs. For the purposes of this paper the following assumptions are made:

1. All expenditures made by the county board of education are in support, directly or indirectly of educational programs.

2. Yearly costs, per student, do not vary significantly K-12.

3. Yearly costs can be reasonably pro-rated on the basis of instructional time devoted to a subject's area, i.e; since math instruction at the elementary level requires one-sixth of the instructional day, one-sixth of the yearly costs per pupil can be reasonably allocated to the math program.

The writer recognizes that assumptions two and three do not accurately reflect the conditions existing in this school system, but the reader will find that they are made only for the purposes of this paper and their accuracy is not essential to the conclusions of this report.

Elementary students in Volusia County receive one hour's instruction in math on a daily basis. In some schools this is done in a self-contained classroom and in others it is done on a departmentalized basis.

The predominant mode of instruction is scope and sequence of a state approved textbook.

For the last three years Volusia County has had a Title III project entitled SMART which has attempted to improve math instruction by developing programmed instruction presented through cassette recorder and providing individualized programs according to the needs of students. The programs are self-pacing and partially self-monitored, but are also monitored by the student's teacher who assists the student with any problems and periodically evaluates his progress.

The math supervisor for the county has stated that the goals of the math curriculum for elementary students are threefold:

1. to provide computational skills in the four basic operations (addition, subtraction, multiplication and division) with whole numbers, decimals, and fractions.

2. to apply these skills accurately and appropriately to problem-solving.

3. to provide a knowledge of those concepts on which higher mathematics is based.

For the purposes of this paper, these goals have been labeled as computational skills, applications, and concepts, and assigned weights of 40, 40, and 20, respectively. These weights are of course, arbitrary but consistent with estimates of importance provided by the math supervisor.

Participants in the SMART program and the control students received one hour per day of math instruction over a regular school year. The teachers of both groups were experienced elementary math teachers. SMART teachers received in-service instruction to familiarize them with the hardware and software to be used in the program.

As a portion of the evaluation of the SMART program, pre and post test scores on three sub-tests of the Stanford Achievement Test were obtained for sixth grade students enrolled in the SMART program and a control group of sixth grade students. There were 291 sixth grade students in the SMART program and 120 controls. The pre-test was administered in September, 1971 and the post-test was administered in May, 1972. Analysis of covariance was used to analyze the results. A complete evaluation report is available at the Volusia County Instructional Center or through the Title III office of the State Department of Education in Tallahassee.

This report will arrive at an efficiency factor based on the benefits of the SMART program and the conventional program as estimated by the Stanford Achievement Test results and the estimated costs using the assumptions previously outlined.

The results of the pre and post test results are given in Table 1. The results are reported in grade equivalent scores and should be read as follows. The average performance for the controls on the pre-test was equivalent to the expected performance of an average student in the fourth grade and sixth month of school.

TABLE 1

STANFORD ACHIEVEMENT TEST--PRE AND POST TEST RESULTS
IN GRADE-EQUIVALENCY SCORES
FOR SMART STUDENTS AND CONTROLS

STANFORD SUB-TESTS	CONTROLS n=120		SMART n=291	
	pre	post	pre	post
COMPUTATIONAL SKILLS	4-6	4-8½	4-7	5-8 1/3
APPLICATIONS	4-6	5-0	5-0	5-8
CONCEPTS	5-1	5-4	5-1	6-2

Table 2 shows the net gain in months from the pre to the post test. This table should be read as follows: In the area of concepts, the control students showed an average gain of three months while the SMART students showed an average gain of eight months.

TABLE 2

AVERAGE GAIN IN MONTHS FOR CONTROL AND SMART GROUPS
BASED ON STANFORD ACHIEVEMENT TEST SCORES

STANFORD SUB-TESTS	CONTROLS	SMART
COMPUTATIONAL SKILLS	2½	11 1/3
APPLICATIONS	4	8
CONCEPTS	3	8

As previously stated, educational costs are difficult to retrieve. For purposes of this analysis the figure of $739* per pupil (in average daily membership) is used. Pro-rating costs on the same basis as instructional time, we arrive at an estimate of $123.17 as the total cost of providing a year of math instruction in Volusia County. If we assign the weights of 40-40-20 to the three goals of the elementary program, we arrive at the instructional costs for each of the goal areas as presented in Table 3. The instructional costs are slightly higher for SMART students, since the direct costs of this program for 1971-72 have been prorated among the participants. This was approximately $2.30 per student.

TABLE 3

AVERAGE COST PER YEAR OF MATH INSTRUCTION
FOR STATED PROGRAM GOALS

PROGRAM GOALS	CONTROL	SMART
COMPUTATIONAL SKILLS	$ 49.27	$ 50.19
APPLICATIONS	49.27	50.19
CONCEPTS	24.63	25.09
PROGRAM COSTS	$123.17	$125.47

*Source: Superintendent's 3rd Annual Statistical Report - School Year 1971-1972

If we divide the costs (presented in Table 3) by the average month's gain (presented in Table 2), we arrive at an estimate of the average cost per month of gain for program goals. These data are presented in Table 4.

TABLE 4

AVERAGE COST PER MONTH OF GAIN

PROGRAM GOALS	CONTROLS	SMART
COMPUTATIONAL SKILLS	$ 19.71	$ 4.43
APPLICATIONS	16.42	6.27
CONCEPTS	6.16	3.14
	$ 41.29	$ 13.87

These results indicate that the SMART method of achieving stated program goals is far more efficient than the conventional methods of instruction and when evaluated on a cost/benefits basis, SMART is more effective by a factor of approximately 4 to 1.

The reader may wish to challenge some of the assumptions made by this analysis. It is obvious that much room for debate exists. It is felt however, that a change in assumptions and any alternate method of evaluation would yield a similar ratio of cost to benefits in favor of the SMART program.

OBJECTIVE #1

The 5th and 6th grade students will be able to use computational skills more nearly commensurate with their aptitude as evidenced by pre-post test gains of the Stanford Math Achievement Tests when compared with a control group.

OBJECTIVE #2

The 5th and 6th grade students will be able to use computational skills more nearly commensurate with their aptitude as evidenced by pre-post test gains of the Math Symbols and Vocabulary Test when compared with a control group.

OBJECTIVE #3

The 6th grade students will be able to use computational skills more nearly commensurate with their aptitude as evidenced by pre-post gains on the Volusia County Math Survey when compared with a control group; the general ability of the experimental and control groups will be measured by the Toga Test.

Operational definition:

"Computational skills" - defined as those facts and algorithmic processes necessary to solve basic math problems.

Procedures and Instruments:

Stanford Achievement Test
Volusia County Survey Test
Math Symbols and Vocabulary Test
Toga

Findings and Conclusions:

The gains were in favor of the experimental group at the .01 level in the 5th and 6th grades. There was no significant difference between 1971 and 1972 general ability of the 6th graders. The 1972 group using SMART showed much greater computational skill than the 1971 non-SMART group. There was no significant difference in the reading scores on the Toga Test, but there was significant difference on the Math Symbols and Vocabulary Test in favor of the experimental group.

ANALYSIS OF COVARIANCE

GRADE 5 Test 1 Arithmetic Computation

	Pre	Post	Gain	Difference	Significan
SMART	20.55	28.12	7.57	6.81	1%
Control	18.95	19.71	.76		

Test 2 Arithmetic Concepts

	Pre	Post	Gain	Difference	Significanc
SMART	17.54	23.32	5.78	4.02	1%
Control	15.00	16.76	1.76		

Test 3 Arithmetic Applications

	Pre	Post	Gain	Difference	Significanc
SMART	18.21	22.32	4.11	4.15	1%
Control	14.52	14.48	-.04		

Test 4 Math Symbols and Vocabulary

	Pre	Post	Gain	Difference	Significanc
SMART	21.45	29.87	8.42	4.39	1%
Control	18.90	22.93	4.03		

Test 5 Attitude

	Pre	Post	Gain	Difference	Significanc
SMART	16.82	17.20	.38	.80	Not
Control	15.02	14.60	-.42		

ANALYSIS OF COVARIANCE

GRADE 6	Test 1	Arithmetic Computation			
	Pre	Post	Gain	Difference	Significance
SMART	20.47	30.34	9.87	8.33	1%
Control	20.07	21.61	1.54		

	Test 2	Arithmetic Concepts			
	Pre	Post	Gain	Difference	Significance
SMART	18.00	23.62	5.62	4.16	1%
Control	16.61	18.07	1.46		

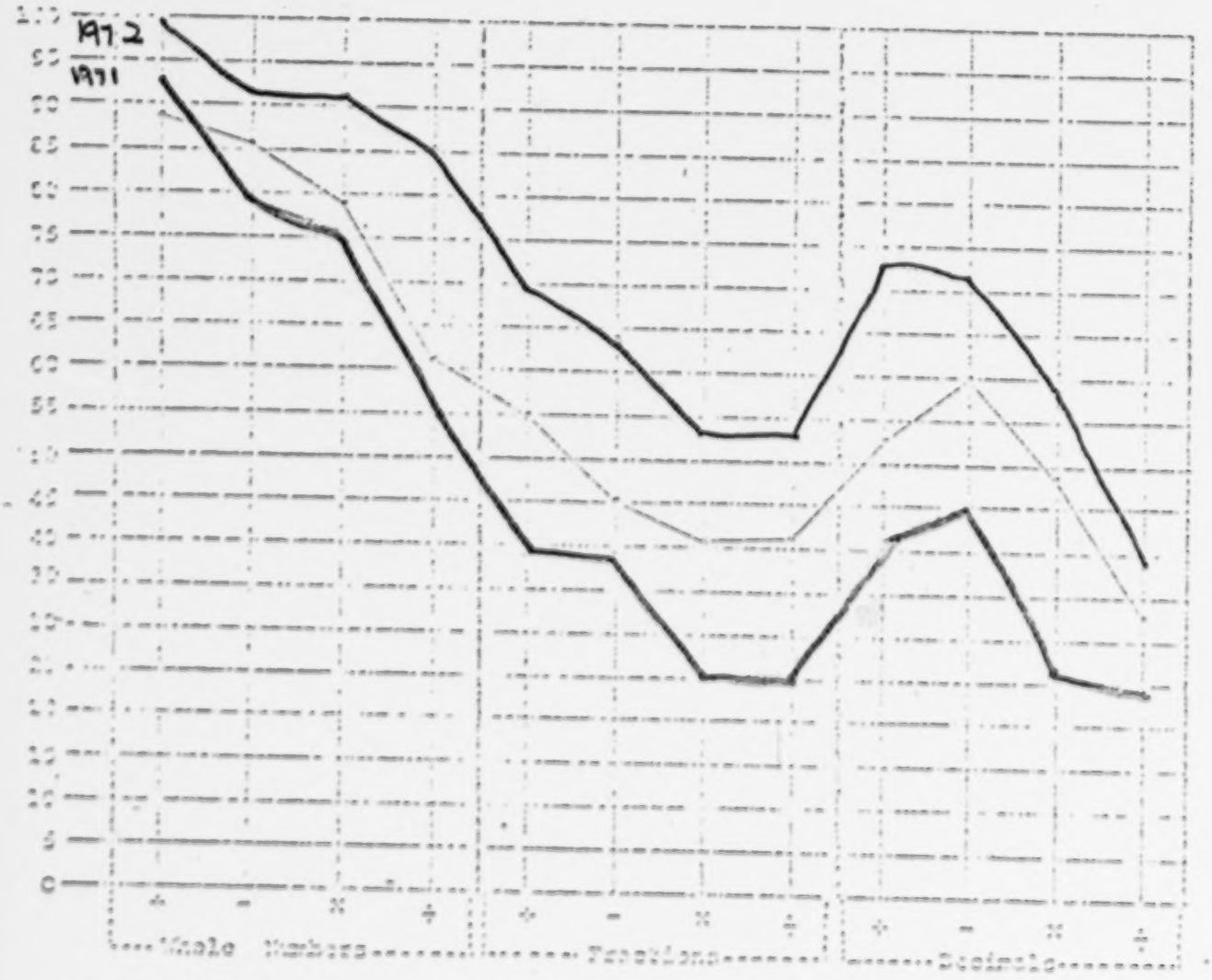
	Test 3	Arithmetic Applications			
	Pre	Post	Gain	Difference	Significance
SMART	18.59	23.16	4.57	2.16	1%
Control	16.19	18.60	2.41		

	Test 4	Math Symbols and Vocabulary			
	Pre	Post	Gain	Difference	Significance
SMART	23.27	31.19	7.92	5.06	1%
Control	22.61	25.47	2.86		

	Test 5	Attitude			
	Pre	Post	Gain	Difference	Significance
SMART	17.36	21.86	4.50	5.52	1%
Control	18.09	17.07	-1.02		

The graphs which follow are results of a test given to all Volusia County sixth grade students. The three graphs are of schools having Project SMART in 1972, but not in 1971. This year's graph of Starke and Ormond Beach Elementary are above last year's by at least 10% for all operations; South Daytona's 1972 graph is above in all but two cases.

VOLUSIA COUNTY 6th GRADE MATH SURVEY TEST - MAY 1972



SCHOOL Orange Park

Tested 97

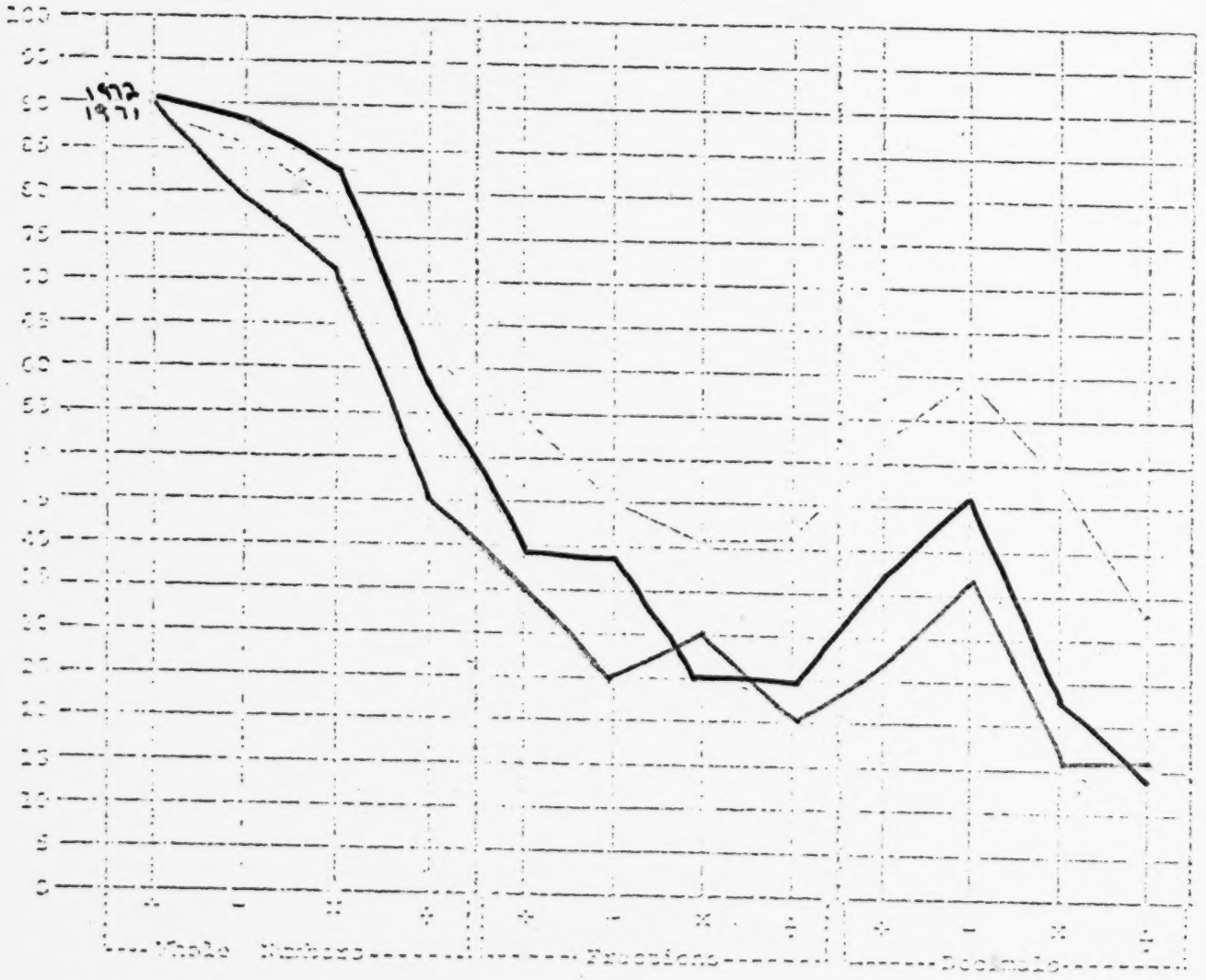
COUNTY TOTALS: MAY 1972

SCHOOL TOTALS: MAY 1972

SCHOOL TOTALS: MAY 1972

% OF STUDENTS WHO GOT 3 OR MORE RIGHT OUT OF 5 ITEMS IN EACH CATEGORY

VOLUSIA COUNTY 6th GRADE MATH SURVEY TEST - MAY 1972



SCHOOL SOUTH DAYTONA

Tested 104

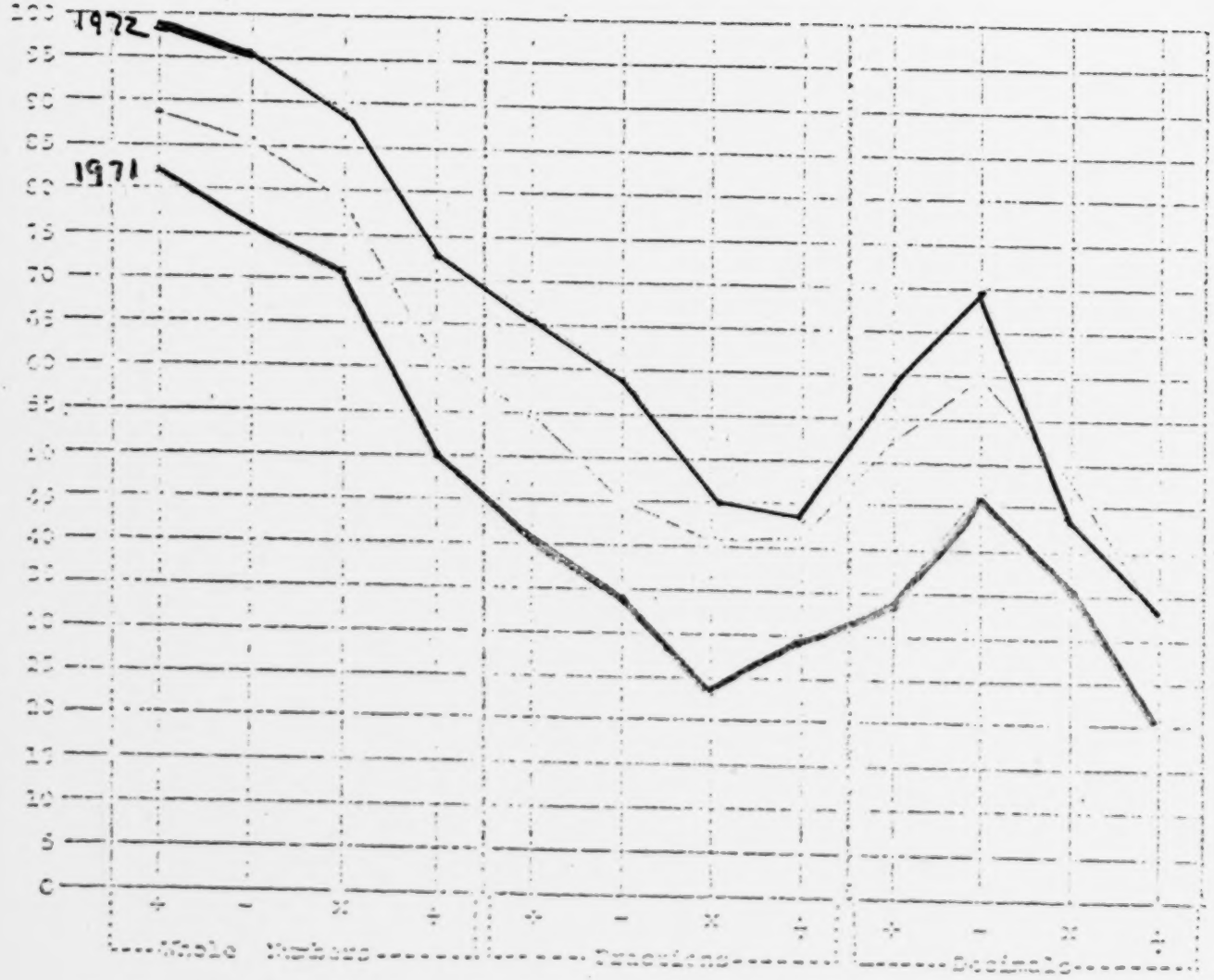
COUNTY TOTALS: MAY 1972

SCHOOL TOTALS: MAY 1971

SCHOOL TOTALS: MAY 1972

% OF STUDENTS WHO GOT 3 OR MORE RIGHT OUT OF 5 ITEMS IN EACH CATEGORY

VOLUSIA COUNTY 6th GRADE MATH SURVEY TEST - MAY 1972



SCHOOL STAAKE

Tested 40

COUNTY TOTALS: MAY 1972

SCHOOL TOTALS: MAY 1971

SCHOOL TOTALS: MAY 1972

% OF STUDENTS WHO GOT 3 OR MORE RIGHT OUT OF 5 ITEMS IN EACH CATEGORY

INTER-OFFICE MEMORANDUM

TO: JACK DUNCAN

FROM: CRANE WALKER, PROGRAM EVALUATION SUPERVISOR

SUBJECT: EQUIVALANCE OF SMART STUDENTS AT ORMOND BEACH ELEMENTARY

The following data* were obtained on the two sixth grade groups for 1970 and 1971 pertaining to their Test of General Ability:

	1970	1971
Mean Raw Score	52.56	54.07
Standard Deviation	13.86	12.59
Number of Students	91	80

The observed difference was tested using Fisher's Z test of difference between means. The z value obtained was .75 which is not significant at the .05 level.

Both groups were functioning in a normal range of intelligence with no significant differences between the two groups in ability

*Data used for comparisons were 5th grade TOGA scores for both groups.

INTER-OFFICE MEMORANDUM

TO: JACK DUNCAN

FROM: CRANE WALKER, PROGRAM EVALUATION SUPERVISOR

SUBJECT: EQUIVALANCE OF SMART STUDENTS AT SOUTH DAYTONA ELEMENTARY

The following data* were obtained on the two sixth grade groups for 1971 and 1972 pertaining to their Test of General Ability:

	1971	1972
Mean Raw Score	48.24	51.01
Standard Deviation	15.05	14.09
Number of Students	110	66

The observed difference was tested using Fisher's Z test of difference between means. The z value obtained was 1.23 which is not significant at the .05 level.

Both groups were functioning in a normal range of intelligence with no significant differences between the two groups in ability.

*Data used for comparisons were 5th grade TOGA scores for both groups.

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INTER-OFFICE MEMORANDUM
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TO: JACK DUNCAN

FROM: CRANE WALKER, PROGRAM EVALUATION SUPERVISOR

SUBJECT: EQUIVALANCE OF SMART STUDENTS AT E. I. STARKE ELEMENTARY

The following data* were obtained on the two sixth grade groups for 1971 and 1972 pertaining to their Test of General Ability:

	1970	1971
Mean Raw Score	49.11	52.33
Standard Deviation	14.40	13.38
Number of Students	66	80

The observed difference was tested using Fisher's Z test of difference between means. The z value obtained was 1.39 which is not significant at the .05 level.

Both groups were functioning in a normal range of intelligence with no significant differences between the two groups in ability.

*Data used for comparisons were 5th grade TOGA scores for both groups.

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INTER-OFFICE MEMORANDUM

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TO: JACK DUNCAN

FROM: CRANE WALKER, PROGRAM EVALUATION SUPERVISOR

SUBJECT: READING SCORES FOR PROJECT SMART STUDENTS

Very little data is available on which conclusions can be drawn. Stanford Achievement Tests were administered to sixth grade students at Starke Elementary School in Spring of 1971 and 1972. The results on the Word Meaning Subtest were as follows:

	N	MEAN	STANDARD DEVIATION
1971	60	23.20	9.66
1972	88	25.66	10.87

A "t" test on the observed difference yielded a value of 1.42 which is non-significant. The change in scores was in the predicted direction but was not statistically significant. You have the data relating to Math Symbols and Vocabulary which should also be reported.

CONCLUSIONS AND RECOMMENDATIONS

Introduction

Project SMART is designed to individualize mathematics instruction using specially prepared tapes and student study sheets. Each student has a tape player equipped with earphones. By using tapes that are correlated with the printed material each student is allowed to proceed at a rate commensurate with his ability.

The recorded mathematics lessons call for very little whole class lecture-type instruction and allows the teacher to spend a major portion of the time in working individually with students.

Innovativeness

Procedures used in Project SMART are found in less than five percent of the school districts in the State of Florida. Although this project might not be considered highly innovative by 1973 standards, it was definitely so at its inception, since this project began with the development of the cassette tape. Project SMART has individualized mathematics instruction in a most unusual and interesting manner.

Effectiveness/Success

Evaluation logic and rationale as well as described design, procedures and methodology seem to have been the weakest feature of the project. Accuracy of the data processing, selection of assessment instruments, and the data analyses that were performed were the stronger features of the evaluation. Numbers and kinds of subjects for the experimental

and control groups seem to have been selected without any apparent logic or rationale. In addition, conclusions from the data analyses, in most cases, must be inferred from computer printouts because clearly stated narrative conclusions based on the data analysis were not presented. Pre and post test scores of experimental students by various instruments seemed to demonstrate educational significance for the project.

Cost Effectiveness Analysis/Economical

A major consideration in any innovative educational endeavor is cost effectiveness. This program has achieved educationally significant gains at a very modest cost.

Start up or installation cost per pupil is based on full day utilization serving approximately 180 students with each 33 sets of materials. Local school costs could, in many instances, be substantially less than that presented in the project documentation if any of the hardware is already in the school.

Continuation costs would appear to be very small for this project and could probably be completely absorbed by reallocation of existing funds.

Exportability

There is no question as to whether other school districts will find this practice feasible since there are already second and third generation classes that have installed SMART. The cost effective analysis by Dr. Walker indicates that the cost per month of gain is almost three times less than the

existing program. If this benefit to cost ratio is maintained in this school system and sustained in other school systems then the adoption of the practice should be widespread. The project is presently capable of preparing the tapes and booklets needed by other school systems. If this dissemination effort is continued or expanded the practice can be communicated easily to other school districts.

Conclusion

Project SMART is a unique and unusual method of individualizing mathematics instruction using printed programmed materials along with cassette tapes.

Educationally and statistically significant gains have been achieved although adopting systems should probably give more careful attention to research design and data treatment to ensure validity of results.

This project can be adopted by another school system for a very nominal start-up cost and can probably be maintained by a reallocation of existing funds.

Although Project SMART is a complete individualized mathematics instruction program any adopting system would probably modify and add-to this program to suit their particular needs.